(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
3 February 2005 (03.02.2005)

PCT

(10) International Publication Number
WO 2005/009523 A1

(51) International Patent Classification⁷: **A61M 25/00**, A61B 17/12

(21) International Application Number: PCT/US2004/022644

(22) International Filing Date: 14 July 2004 (14.07.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/488,644 18 July 2003 (18.07.2003) US

(71) Applicant *(for all designated States except US)*: **SCIMED LIFE SYSTEMS, INC.** [US/US]; One SciMed Place, Maple Grove, MN 55311-1566 (US).

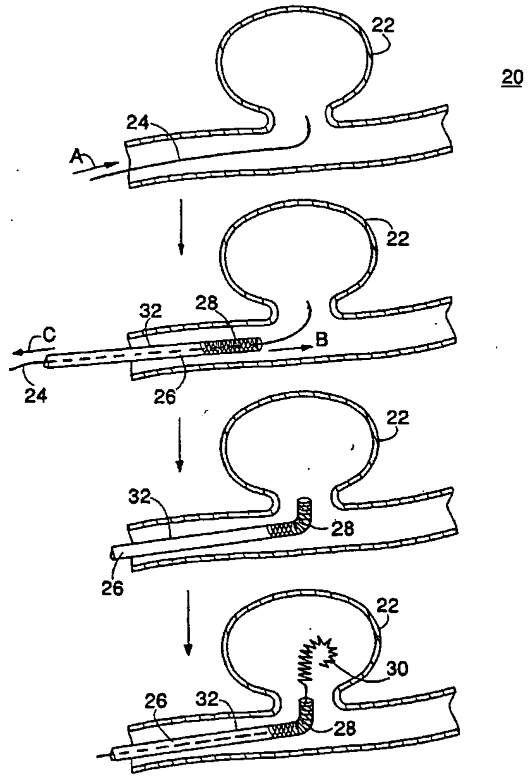
(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **DAO, Kinh-Luan** [US/US]; 67 Allen Street, Randolph, MA 02368 (US). **LIU, Changdeng** [CN/US]; 1 Northwood Road, Apt. 114, Storrs, CT 06268 (US). **MATHER, Patrick** [US/US]; 5 Thomas Drive, Storrs, CT 06268 (US). **SAHATJIAN, Ronald, A.** [US/US]; 29 Saddle Club Road, Lexington, MA 02420 (US). **ZHONG, Sheng-Ping** [CN/US]; 21 Charina Road, Northborough, MA 01532 (US).

(74) Agent: GAGEL, John, J.; Fish & Richardson P.C., 225 Franklin Street, Boston, MA 02110-2804 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

[Continued on next page]

(54) Title: MEDICAL DEVICES



(57) Abstract: A medical device, such as, for example, a catheter, includes a tubular member having a first portion having a shape memory polymer.

WO 2005/009523 A1

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

MEDICAL DEVICES

CLAIM OF PRIORITY

This application claims priority under 35 USC §119(e) to U.S. Provisional Patent Application Serial No. 60/488,644, filed on July 18, 2003, the entire contents of which are hereby incorporated by reference.

TECHNICAL FIELD

The invention relates to medical devices, such as, for example, catheters.

BACKGROUND

The body includes various blood vessels, for example, arteries. Sometimes, a wall portion of a blood vessel becomes stretched and thin such that the blood vessel develops a bulge, or an aneurysm. An aneurysm is potentially dangerous because it can break open, thereby causing the vessel to bleed. Bleeding can result in a stroke (e.g., in a brain aneurysm) or death.

One method of treating an aneurysm is to fill the aneurysm. For example, the aneurysm can be filled with helically wound coils or braids, sometimes called vaso-occlusive devices. The vaso-occlusive devices can promote formation of a clot and a mass surrounding the devices that fill and seal the aneurysm. As a result, the weakened wall of the vessel is not exposed, e.g., to pulsing blood pressure in the vessel, and the possibility of the aneurysm breaking can be reduced.

The vaso-occlusive devices can be delivered into an aneurysm by endovascular techniques using a guidewire and a catheter. The guidewire is first steered through the body and to the aneurysm. Next, the catheter is slid over the emplaced guidewire and tracked to the aneurysm, e.g., at the mouth of the aneurysm, and the guidewire is removed. The vaso-occlusive devices can then be delivered through a lumen of the catheter and into the aneurysm.

SUMMARY

The invention relates to medical devices.

In one aspect, the invention features a catheter having a portion, e.g., a distal portion, including a shape memory polymer. The catheter can be delivered to a target site, e.g., near an aneurysm, in a first configuration; and at the target site, the portion of the catheter can be changed to a second, different configuration. For example, the catheter can be delivered with the distal portion in a straight position, and subsequently, the distal portion can be changed to a bent configuration that facilitates delivery of vaso-occlusive devices into the aneurysm.

The shape memory polymer portion allows the catheter to be delivered, for example, without relying on a guidewire to straighten the catheter and/or without being deformed by a tortuous vasculature. After changing configuration, the shape memory polymer portion provides a stable (e.g., non-slipping) pathway for delivery of the vaso-occlusive devices. By securely staying in the predetermined changed configuration, the catheter reduces the likelihood of buckling or other forces that can exert stress on the aneurysm.

In another aspect, the invention features a medical catheter including a tubular member having a first portion including a shape memory polymer.

Embodiments can include one or more of the following features. The first portion is a distal portion of the tubular member, or a distalmost portion of the tubular member. The first portion further includes a material susceptible to heating by magnetic effects. The tubular member has a body including a polymer different than the shape memory polymer. An end of the body can be connected to an end of the first portion. The first portion surrounds a portion of the body.

The shape memory polymer can include, for example, polynorbonene, polycaprolactone, polyene, nylon, polycyclooctene (PCO), a blend of polcyclooctene and styrenebutadiene rubber, polyurethane, polyurethane copolymers, and/or a polyvinyl acetate/polyvinylidinefluoride.

The catheter can be in the form of a 5 French catheter or smaller.

The first portion can include a radiopaque material, a material visible by magnetic resonance imaging, and/or an ultrasound contrast agent.

In another aspect, the invention features a method including introducing a catheter to a target site, the catheter having a distal portion is a first configuration, and changing the distal portion from the first configuration to a second configuration.

Embodiments can include one or more of the following features. Changing the distal portion includes heating the distal portion, and/or applying radiofrequency energy to the distal portion. The method further includes passing a medical device, such as, for example, a vaso-occlusive device through the catheter.

The distal portion can be the distalmost portion of the catheter. The target site can be proximate an aneurysm.

In another aspect, the invention features a wire having a shape memory polymer coating over a portion of the wire, such as the tip of the wire.

Other aspect, features, and advantages of the invention will be apparent from the description of the preferred embodiments thereof and from the claims.

DESCRIPTION OF DRAWINGS

Fig. 1 is an illustration of an embodiment of a method treating an aneurysm.

Fig. 2A is an illustration of an embodiment of a catheter in a generally straight position; and Fig. 2B is an illustration of the catheter of Fig. 2A in a bent position.

Fig. 3A is an illustration of an embodiment of a catheter in a generally straight position; and Fig. 3B is an illustration of the catheter of Fig. 3A in a bent position.

DETAILED DESCRIPTION

Referring to Fig. 1, a method 20 of treating an aneurysm 22 is shown. Method 20 includes delivering a guidewire 24 (e.g., a steerable guidewire) to aneurysm 22 using conventional endovascular techniques (arrow A). Next, a catheter 26 is passed over guidewire 24, and advanced to near aneurysm 22 (arrow B). Catheter 26 includes a body 32 and a distal portion 28 including a shape memory polymer that is configured to remember a predetermined configuration. During advancement of catheter 26, distal portion 28 is in a generally straight configuration (e.g., collinear with body 32), which allows the catheter to easily track a tortuous vascular path. Guidewire 24 is then removed (e.g., withdrawn proximally, arrow C). Next, distal portion 28 is changed from the straight configuration to the predetermined configuration (as shown, a bent configuration). Distal portion 28 is then introduced into aneurysm 22, and vaso-occlusive coils 30 are introduced through catheter 26 and into the aneurysm, according to conventional methods.

Catheter 26 is generally an elongated tube having one or more lumens. Referring to Figs. 2A and 2B, catheter 26 generally includes body 32 and distal portion 28. Body 32 can be a standard catheter shaft made of conventional, biocompatible polymers, as described in, e.g., U.S.S.N. 09/798,749, filed March 2, 2001, and entitled "Multilayer Medical Balloon". As shown, distal portion 28 is an extruded tube having a tapered portion. In some embodiments, referring to Figs. 3A and 3B, distal portion 28 is a sleeve that fits over a distal portion of body 32. Body 32 can have a tapered distal end. Distal portion 28 can be attached to body 32, for example, by laser welding, gluing with an epoxy, melt bonding, or heat shrinking. In other embodiments, distal portion 28 can be a coating of a shape memory polymer applied to body 32, e.g., by dipping the body into a solution containing a shape memory polymer. Distal portion 28 can be, for example, about six to ten inches long.

Distal portion 28 includes one or more shape memory polymers (SMPs). Suitable shape memory polymers include elastomers that exhibit melt or glass transitions at temperatures that are above body temperature, e.g., at about 40 to 50 °C, and safe for use in the body. Examples of polymers include shape memory polyurethanes (available from Mitsubishi), polynorbornene (e.g., Norsorex (Mitsubishi)), polymethylmethacrylate (PMMA), poly(vinyl chloride), polyethylene (e.g., crystalline polyethylene), polyisoprene (e.g., trans-polyisoprene), styrene-butadiene copolymer, rubbers, or photocrosslinkable polymer including azo-dye, zwitterionic and other photochromic materials (as described in Shape Memory Materials, Otsuka and Wayman, Cambridge University Press, 1998). Other shape memory polymers include shape memory plastics available from MnemoScience GmbH Pauwelsstrasse 19, D-52074 Aachen, Germany. Other shape memory materials, such as thermoplastic polyurethanes and polyurethane copolymers, are described in provisional U.S. application No. ______, filed on July 18, 2003, and entitled "Shape Memory Polymers Based on Semicrystalline Thermoplastic Polyurethanes Bearing Nanostructured Hard Segments"; Ge and Mather, "Synthesis of Thermoplastic Polyurethanes Bearing Nanostructured Hard Segments: New Shape Memory Polymers"; and U.S.S.N. 60/418,023, filed October 11, 2002, and entitled "Endoprosthesis", all hereby incorporated by reference in their entirety. The materials can be bioabsorbable or non-bioabsorbable. Mixtures of polymeric shape memory materials can be used.

In some embodiments, the shape memory polymer is crosslinked and/or crystalline. The degree of crosslinking and/or crystallinity is sufficient to resist excessive creep or stress relaxation, e.g., after the polymer is heated. Crosslinking can also be controlled to adjust the melt or glass transition temperature and transition temperature range. In some cases, a narrow transition range, e.g. 10 °C, 5 °C, or less, is desirable. Crosslinking can be achieved by application of radiation, such as e-beam, UV, gamma, x-ray radiation, or by heat-activated chemical crosslinking techniques (e.g., with peroxides). In some radiation crosslinking techniques, the polymer need not be substantially heated to achieve crosslinking.

As noted above, the shape memory polymer is capable of exhibiting shape memory properties such that it can be configured to remember, e.g., to change to, a predetermined configuration or shape. In some embodiments, the shape memory polymer is formed or set to a primary (e.g., stress free) shape during crosslinking. For example, distal portion 28 can be crosslinked in a bent configuration. Subsequently, the polymer can be formed into a temporary shape, for example, by heating the polymer to a softening point (e.g., T_m or T_g), deforming the polymer, and cooling the polymer to below a softening point. When the polymer is subsequently heated to above the softening temperature, the polymer can recover to its primary form.

A number of methods can be used to effect the transition of the polymer from its temporary configuration to its primary configuration. Catheter 26 can carry a heating device. For example, a resistive heater or radiofrequency (RF) heater can be provided in the interior of the catheter. Alternatively or in addition, the polymer can be compounded to include a material, such as magnetic particles, that is susceptible to heating by magnetic effects, such as hysteresis effects. A magnetic field can be imposed on the stent body by a source on a catheter or outside the body. Suitable magnetic particles are available as the Smartbond™ System from Triton Systems, Inc., Chelmsford, MA. Heating by magnetic effects is discussed in U.S. Patent No. 6,056,844.

In general, the size and configuration of catheter 26 is not limited. In some embodiments, catheter 26 is in the form of a 5 French catheter or smaller, e.g., a 4 French, 3 French, 2 French, or 1 French catheter. Catheter 26 can have a length of, for example, about

240 cm to about 3.5 meters. Examples of catheters include aneurysm catheters, guide catheters, urology catheters, and microcatheters (all available from Boston Scientific Corp., Natick, MA).

The angle at which distal portion 28 can be bent relative to body 32 can also vary. In some cases, the angle (ϕ) defined by distal portion 28 and body 32 (Fig. 2B) is between about 20° and about 180°. For example, the angle (ϕ) can be greater than or equal about 20°, 40°, 60°, 80°, 100°, 120°, 140°, or 160°; and/or less than or equal to about 180°, 160°, 140°, 120°, 100°, 80°, 60°, or 40°.

In some embodiments, distal portion 28 contains a radiopaque material, a material that is visible by magnetic resonance imaging (MRI), and/or an ultrasound contrast agent. The materials or agent allows catheter 26 to be tracked and monitored, e.g., by X-ray fluoroscopy, MRI, or ultrasound imaging. Examples of radiopaque materials include tantalum, tungsten, platinum, palladium, or gold. The radiopaque material, e.g., powder, can be mixed with the shape memory polymer. Alternatively or in addition, the radiopaque material, e.g., a band of radiopaque material, can be placed on catheter 26 at selected positions, such as, for example, adjacent to distal portion 28.

Examples of MRI visible materials include non-ferrous metal-alloys containing paramagnetic elements (e.g., dysprosium or gadolinium) such as terbium-dysprosium, dysprosium, and gadolinium; non-ferrous metallic bands coated with an oxide or a carbide layer of dysprosium or gadolinium (e.g., Dy_2O_3 or Gd_2O_3); non-ferrous metals (e.g., copper, silver, platinum, or gold) coated with a layer of superparamagnetic material, such as nanocrystalline Fe_3O_4, $CoFe_2O_4$, $MnFe_2O_4$, or $MgFe_2O_4$; and nanocrystalline particles of the transition metal oxides (e.g., oxides of Fe, Co, Ni). Powder of MRI visible materials can be mixed with the shape memory polymer.

The ultrasound contrast agent can be any material that enhances visibility during ultrasound imaging. An ultrasound contrast agent can include a suspension having trapped bubbles of sufficient size to deflect sound waves.

Distal portion 28 can include a drug or a therapeutic agent. For example, distal portion 28 can include an antithrombolytic agent, such as heparin, to reduce clotting on the catheter. Other examples of drugs or therapeutic agents are described in U.S.S.N. 10/232,265, filed August 30, 2002, hereby incorporated by reference.

In some cases, the catheter can be formed into a desired shape by a user (such as a physician) at the time of a procedure, e.g., using heat (steam). The shape memory properties can be used to impart a predetermined shape, which the user can try. If the predetermined shape is not adequate (e.g., unsuccessful), the user can heat the shape memory material of the catheter outside the body and re-shape the catheter (e.g., using steam or hot water) to a second predetermined shape.

The following examples are illustrative and not intended to be limiting.

Example 1

The following example shows a method of making a catheter having portion including a polycyclooctene/styrene butadiene rubber blend, a blend of shape memory polymers. Polycyclooctene and blends of shape memory polymers are described in U.S.S.N. 10/683,559, entitled "Crosslinked Polycyclooctene", and U.S.S.N. 10/683,558, entitled "Blends of Amorphous and Semicrystalline Polymers Having Shape Memory Properties", both filed on October10, 2003.

To form the blend, the polymers were compounded. Styrene butadiene rubber was cut in a Willy mill to 1-2 mm mesh. The rubber and the polycyclooctene were mixed in a ratio of 65% by weight polycyclooctene and 35% by weight styrene butadiene rubber, and ran in a dry blender for about 30 minutes. The mixture was then placed in a bra blender with two twin-screw head running at 20-25 RPM at 100 °C. The blended mixture was then placed in a room temperature water bath and pelletized.

Next, the pellets were extruded. The pellets (about 500 grams) were extruded in a Davis Standard extruder (3/4 to one inch) running with a feed temperature of about 50 °C, a second zone at about 65 °C, a third zone at about 80 °C, and a die head temperature of about 80 °C. The pellets were extruded through a tubular die and using pressurized air to help maintain the patency of the lumen of the extruded tube. The extruded tube was fed to a room temperature water bath and cut to length (e.g., about 6 inches). The tube can have, for example, a 0.0305 inch O.D. and a 0.027 inch I.D.

Next, the shape memory polymer tube (e.g., about 5 cm) was placed on a distal portion of a catheter. The catheter had a guidewire placed through the lumen of the catheter. The catheter was attached to a sleeving machine equipped with movable and heatable clamps. Next, a heat shrink tubing (available from Zeus or Target) was placed over the shape memory polymer tube. The clamps were heated to about 175 °C to about 200 °C and moved at a rate of 13.5-17 cm/min to shrink the heat shrink tubing and to secure the shape memory tubing to the catheter. Typically, only one pass of the clamps is needed. In some cases, the higher the concentration of styrene butadiene rubber in the blend, the higher the temperature is needed; for example, a blend including 35% by weight styrene butadiene was heated to about 195 °C.

Then, the catheter was removed from the sleeving machine, and the heat shrink tubing was stripped from the catheter under a microscope.

The catheter was then shaped, e.g., into a curve (e.g., J shape) or a straight line. A shaping mandrel can be placed in the lumen of the catheter.

The catheter was then sent to a facility (such as Steris Isomedix) for crosslinking with gamma radiation. Depending on the thickness of the shape memory polymer portion, the polymer portion was irradiated with between about 1 and about 25 megarads. For microcatheters, about 1 megarad was irradiated.

Example 2

A shape memory polymer solution was prepared by dissolving fifteen grams of polynorbonene (Nosorex, from Mitsubishi) and three grams of Kraton 1650 G (GLS Corp.) in 500 mL of xylene. The solution was heated to about 70 °C and stirred on a magnetic stirring plate at a low setting (about 50 rpm) for about 30 minutes.

A curved mandrel was inserted into a catheter (Imager catheter (urology) or Renegade catheter (neurology), available from Boston Scientific Corp.) to provide a curved catheter. The curved catheter (about 6-10 inches) was dipped into the shape memory solution. Depending on the rate at which the catheter was withdrawn from the solution, it is believed that the thickness of the shape memory polymer is between about 0.001-0.005 inch thick. The catheter was air dried for about twenty minutes. The mandrel was then removed.

The curved catheter was straightened by immersing the catheter in a 50 °C water bath.

The straight catheter can be returned to its curved shape by heating the catheter above body temperature, e.g., 45-50 °C.

All publications, applications, references, and patents referred to above are incorporated by reference in their entirety.

Other embodiments are within the claims.

WHAT IS CLAIMED IS:

1. A medical catheter, comprising:
a tubular member having a first portion comprising a shape memory polymer.

2. The catheter of claim 1, wherein the first portion is a distal portion of the tubular member.

3. The catheter of claim 1, wherein the first portion is a distalmost portion of the tubular member.

4. The catheter of claim 1, wherein the shape memory polymer comprises a material selected from the group consisting of a polynorbonene, a polycaprolactone, a polycyclooctene, a polycyclooctene/styrene butadiene blend, and a polyvinyl acetate/polyvinylidinefluoride.

5. The catheter of claim 1, wherein the first portion further comprises a material susceptible to heating by magnetic effects.

6. The catheter of claim 1, wherein the tubular member has a body comprising a polymer different than the shape memory polymer.

7. The catheter of claim 6, wherein an end of the body is connected to an end of the first portion.

8. The catheter of claim 6, wherein the first portion surrounds a portion of the body.

9. The catheter of claim 1, in the form of a 5 French catheter or smaller.

10. The catheter of claim 1, wherein the first portion further comprises a radiopaque material.

11. The catheter of claim 1, wherein the first portion further comprises a material visible by magnetic resonance imaging.

12. The catheter of claim 1, wherein the first portion further comprises an ultrasound contrast agent.

13. A method, comprising:

introducing a catheter to a target site, the catheter having a distal portion is a first configuration; and

changing the distal portion from the first configuration to a second configuration.

14. The method of claim 13, wherein changing the distal portion comprises heating the distal portion.

15. The method of claim 13, wherein changing the distal portion comprises applying radiofrequency energy to the distal portion.

16. The method of claim 13, wherein the distal portion is the distalmost portion of the catheter.

17. The method of claim 13, wherein the target site is proximate an aneurysm.

18. The method of claim 13 further comprising passing a medical device through the catheter.

19. The method of claim 18, wherein the medical device is a vaso-occlusive device.

20. The catheter of claim 1, wherein the polymer is non-absorbable in a body.

21. The catheter of claim 1, wherein the polymer is absorbable in a body.

22. A method, comprising:

forming a catheter including a shape memory polymer before inserting the catheter into a body, the catheter having a distal portion in a first configuration; and

changing the distal portion from the first configuration to a second configuration.

23. The method of claim 22, wherein the method is performed by a physician.

24. The method of claim 22, comprising heating the polymer.

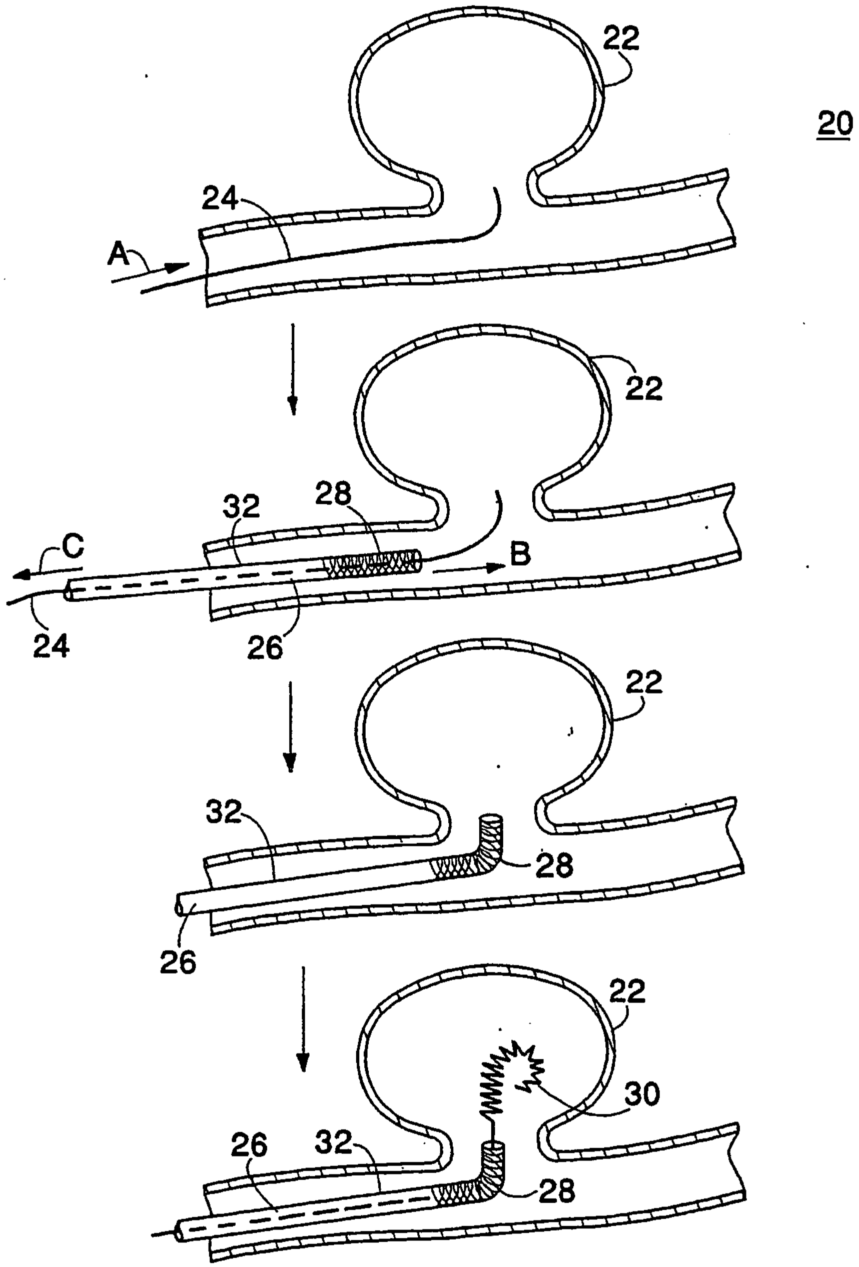


FIG. 1

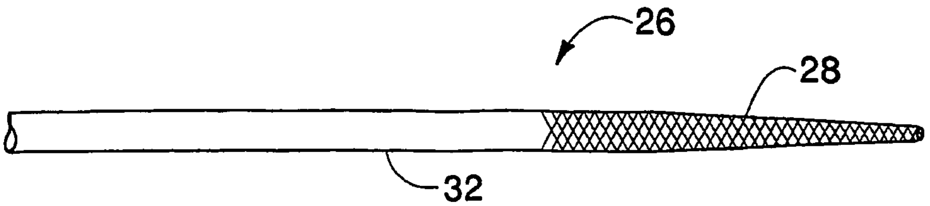


FIG. 2A

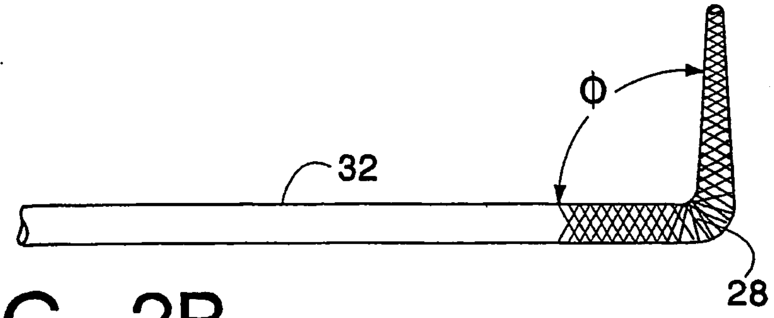


FIG. 2B

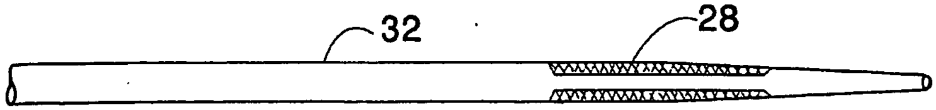


FIG. 3A

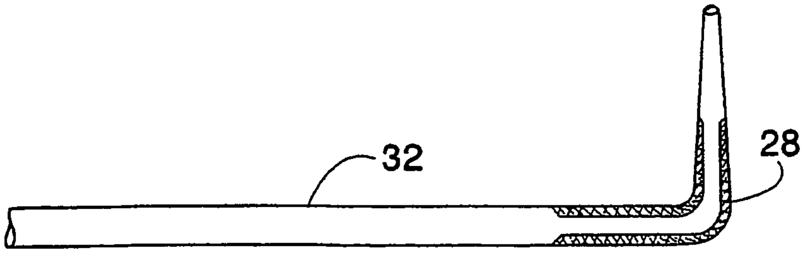


FIG. 3B

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2004/022644

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61M25/00 A61B17/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61M A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 358 238 B1 (SHERRY JOHN) 19 March 2002 (2002-03-19) column 1, line 31 - line 46 column 3, line 54 - column 7, line 25 figures 1-4	1-6,8-12
X	US 6 149 664 A (KURZ DANIEL R) 21 November 2000 (2000-11-21) column 2, line 49 - column 3, line 10 column 3, line 64 - column 6, line 45 figures 1-6	1-7,9-12
A	US 6 077 256 A (MANN MICHAEL J) 20 June 2000 (2000-06-20) column 2, line 52 - line 64	10-12

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search 8 November 2004	Date of mailing of the international search report 17/11/2004
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Compos, F

INTERNATIONAL SEARCH REPORT

[illegible]ternational application No.
PCT/US2004/022644

Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.: 13-24
because they relate to subject matter not required to be searched by this Authority, namely:
Rule 39.1(iv) PCT - Method for treatment of the human or animal body by surgery

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US2004/022644

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6358238 B1	19-03-2002	AU 7083300 A	26-03-2001
		CA 2381784 A1	08-03-2001
		EP 1212116 A1	12-06-2002
		JP 2003508132 T	04-03-2003
		WO 0115763 A1	08-03-2001
US 6149664 A	21-11-2000	AU 5588499 A	21-03-2000
		WO 0012015 A1	09-03-2000
US 6077256 A	20-06-2000	CA 2346303 A1	13-04-2000
		EP 1119389 A1	01-08-2001
		JP 2002526178 T	20-08-2002
		WO 0020066 A1	13-04-2000